

FEMP Exterior Solid-State Lighting Technology Pilot

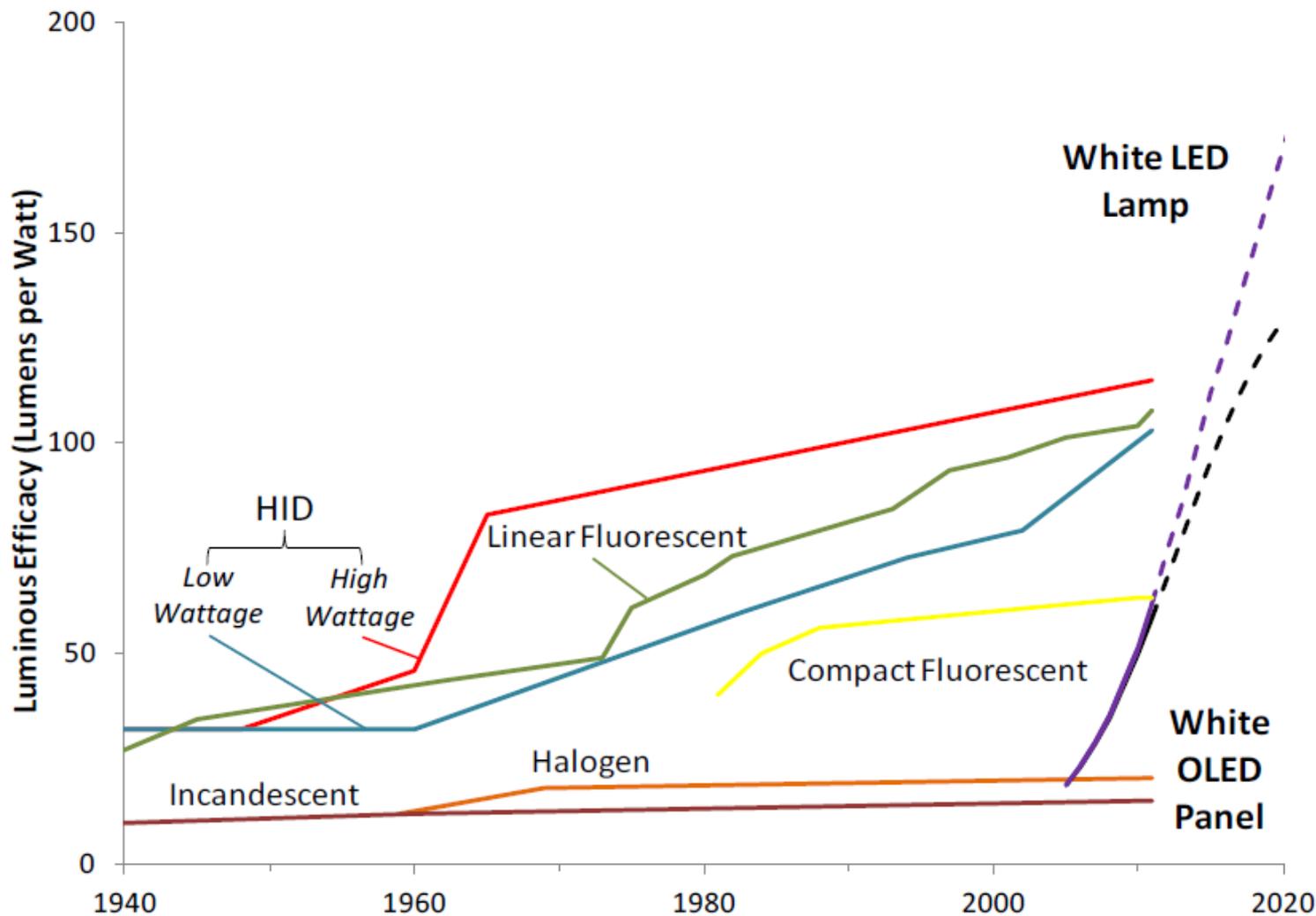
October 17, 2012

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Pacific Northwest National Laboratory
Richland, Washington

- State of SSL Technology
 - Introducing MOBLI
- Federal Energy Management Program (FEMP)
 - Technology Deployment Matrix
 - Federal Exterior Market Size
 - FEMP Exterior SSL Initiative
 - FEMP-designated Efficiency Requirements
 - Plans for FY13
- Commercial Building Energy Alliance (CBEA)
 - About CBEA
 - Lighting Specifications
 - High Efficiency Troffers
 - Parking Structures
 - Parking Lots
 - The LEEP Campaign
- Introducing MOBLI

Energy Savings Potential of Solid-State Lighting



SSL Multi-Year Program Plan, May 2012: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2012_web.pdf

- Value
 - Superior photometrics, CRI
 - Long life
 - Efficiency upside
 - Controllability; instant on, dimming
- Challenges
 - Credibility of manufacturer claims
 - LED color consistency, Lamp to lamp, and over time
 - Reliability: LED device plus optics, thermal management, and other components
 - Dimming, flicker, glare
 - Product cost, availability



Source: Acuity Brands Lighting

- **Purpose:** Identify and rank new and underused technologies which hold the most promise to impact the federal market in order to prioritize resources
- Contains the top 50 ranked technologies.
- Located at:
http://www1.eere.energy.gov/femp/technologies/newtechnologies_workgroup.html

- **Federal Impact (50% Weighting)** – a combination of a technology’s energy savings potential and degree of applicability in the overall federal market.
- **Cost Effectiveness (30% Weighting)** – relative cost of the implementation and average expected return typically reported in case studies as simple payback period.
- **Probability of Success (20% Weighting)** – a combination of characteristics that are mostly qualitative.
 - Strength of Supply Chain
 - Knowledge Base
 - Implementation Difficulty
 - Customer Acceptance (referring to both the facility operator and occupants)

Technologies for Deployment Top 20

Rank	Technology	Category	Weighted Score
1	Spectrally Enhanced Lighting	Lighting	91
2	Low Ambient / Task Lighting	Lighting	88
3	Condensing Boilers	HVAC	86
4	Super T8 Lighting	Lighting	79
5	Commercial Ground-source Heat Pumps	HVAC	66
6	High R-Value Windows	Building Envelope	65
7	Duct Sealants	HVAC	63
8	LED / Solid State Lighting - Interior	Lighting	61
9	LED / Solid State Lighting - Exterior	Lighting	59
10	PC Power Management	Other	58
11	Condensing Water Heaters - gas	Water Heating	58
12	Water Cooled Oil Free Magnetic Bearing Compressor	HVAC	54
13	Integrated Daylighting Systems	Lighting	53
14	Cool Roofs	Building Envelope	53
15	Bi-level Garage / Parking Lot / Pedestrian Lighting	Lighting	53
16	Wrap Around Heat Pipes	HVAC	53
17	Window Films	Building Envelope	53
18	Commercial Energy Recovery Ventilation Systems (ERV)	HVAC	52
19	Air-side Economizers and Filters for Data Centers	HVAC	52
20	Induction Lighting	Lighting	51

Goal - To develop and demonstrate a process by which an emerging, underutilized, commercially proven technology can be placed in a default position for acquisition purposes.



LED RoadStar luminaire with Dynadimmer dimming technology
NGL Recognized Winner 2010

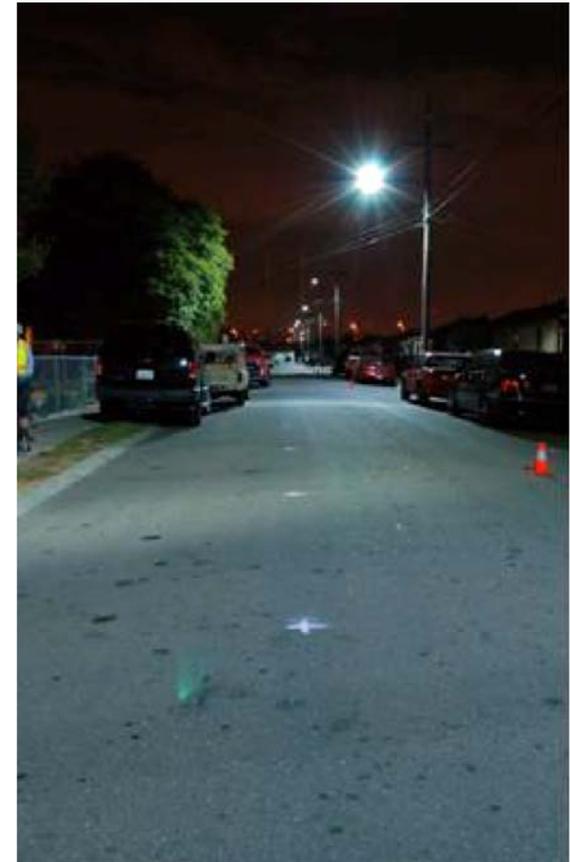
Source: Phillips Roadway Lighting

Why SSL exterior lighting?

- Huge energy savings potential in exterior SSL.
- Exterior applications are ripe for near term implementation through a thoughtful process that recognizes the technology's potential, as well as it's challenges.
- Leverages successful BTP and FEMP efforts.

Unique Federal Sector Challenges

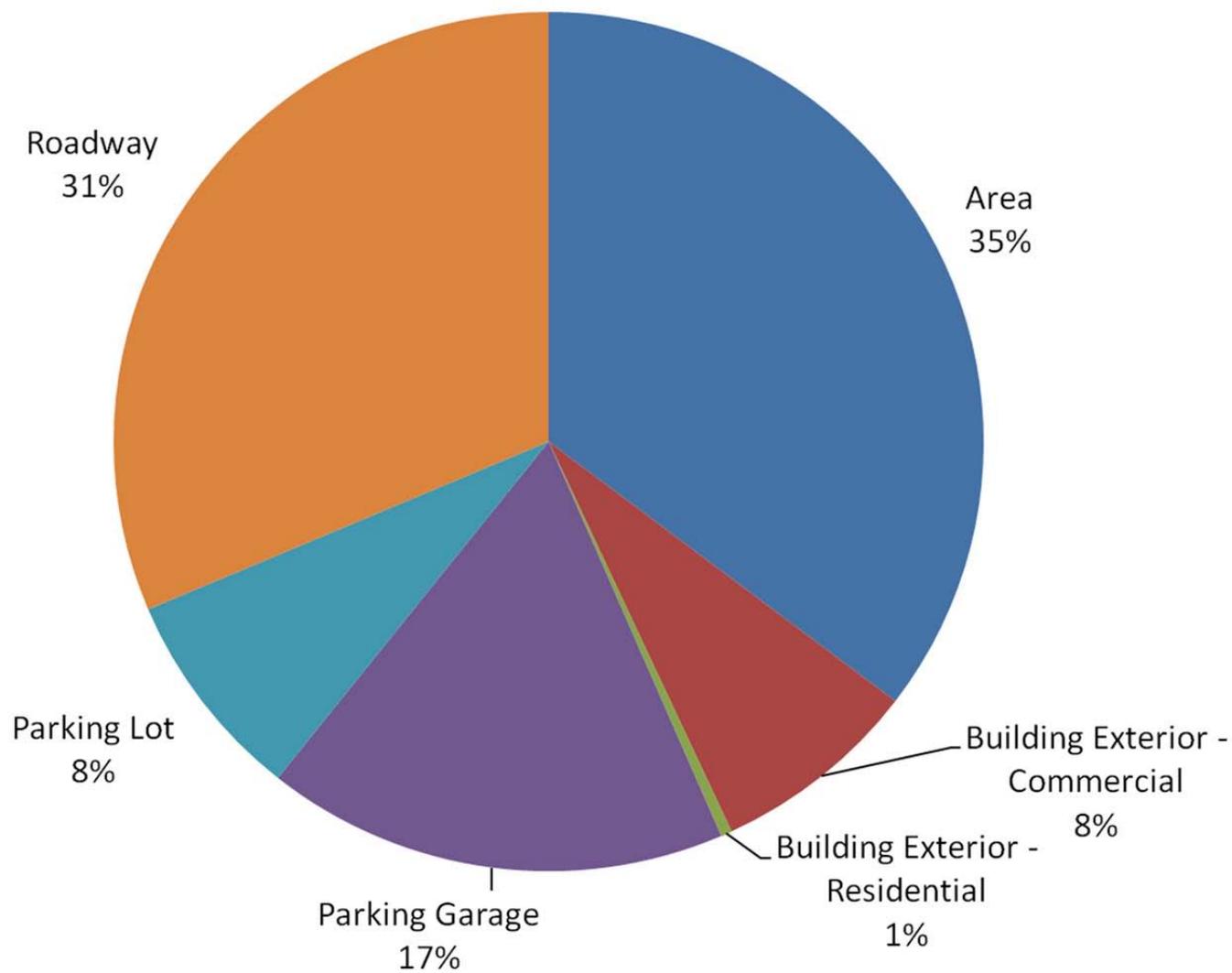
- Market size is large, but unknown, requires study
- Multiple independent lighting policies
 - Navy, Army, Air Force, GSA all have their own criteria.
 - some have embraced SSL, but not in a consistent manner
- Inconsistent implementation of exterior lighting policies at regional/local level
- Acquisition system not well linked to technology advances and assessments
 - newer technology faces risk aversion, inertia
 - first cost vs. best value tension an issue



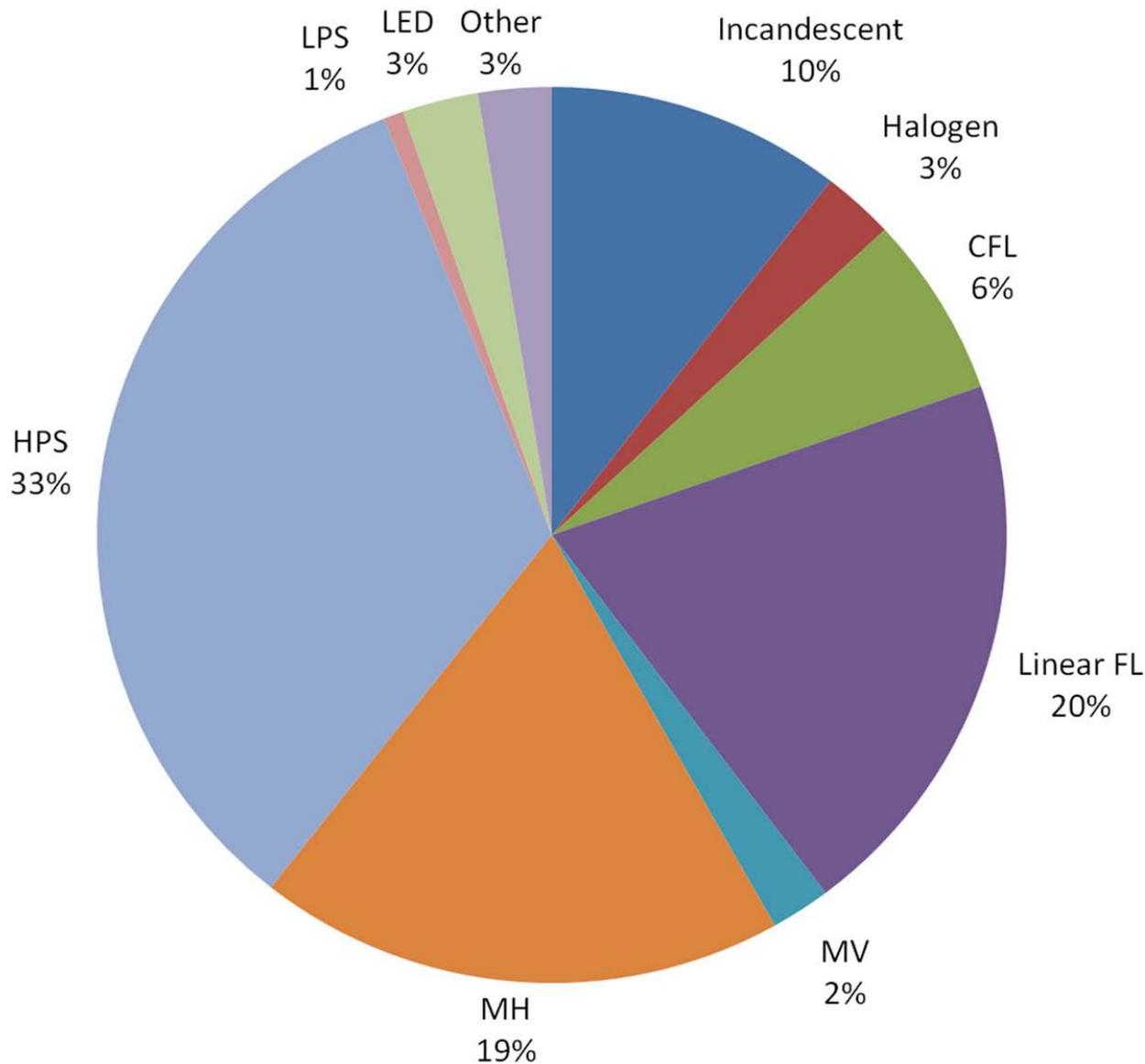
City of Oakland, CA replaced fourteen 121 Watt HPS luminaires (100 nominal Watts) with fourteen 78 Watt LED luminaires (60 nominal Watts)

Source: PNNL

Estimated Federal Outdoor Lighting Energy Use by Lighting Application



Federal Sector Outdoor Lamps by Technology



Outdoor Cost-Effective SSL Potential by Agency

Table 1. Outdoor Cost-Effective SSL Potential by Agency

Agency	Estimated Number of Outdoor Fixtures	Estimated Energy Use (Gigawatt-hours)	Estimated Energy Savings (Gigawatt-hours)*
Agriculture	39,600	7.2	2.0-2.4 (27-33%)
Air Force	890,800	507.0	34.7-106.6 (7-21%)
Army	2,494,700	2,117.0	65.5-602.3 (3-28%)
Corps of Engineers	336,700	360.0	2.0-137.1 (1-38%)
Energy	155,400	85.5	5.4-30.5 (6-36%)
General Services Administration	180,200	48.3	9.3-10.9 (19-23%)
Health and Human Services	33,700	6.3	1.6-1.9 (26-30%)
Homeland Security	255,400	227.0	3.7-84.5 (2-37%)
Interior	1,051,000	1,029.8	12.8-365.2 (1-35%)
Justice	72,500	30.7	2.9-10.7 (9-35%)
Labor	17,000	3.6	0.9-1.0 (25-29%)
National Aeronautics and Space Administration	57,400	30.6	2.2-10.3 (7-34%)
Navy	770,100	480.9	28.8-113.1 (6-24%)
Tennessee Valley Authority	19,400	4.2	1.0-1.2 (24-29%)
Transportation	64,900	54.6	1.5-16.8 (3-31%)
Veterans Affairs	128,500	35.3	6.2-10.9 (17-31%)
Other FRPP Agencies	28,200	9.4	1.3-2.4 (14-26%)
TOTAL	6,595,500	5,037.3	181.8-1,508.0 (4-30%)

*Parenthetical values indicate the estimated percent of cost-effective energy savings to the agency

Federal Collaboration

With support from FEMP, the USACE is developing a policy and implementation plan, including guidance materials, training, qualified product lists, and performance specifications in support of the widespread adoption of exterior SSL in the Federal sector.



Collaboration



USACE



U.S. AIR FORCE



Army Exterior SSL
Policy Announcement

Widespread deployment in Army
and other agencies' facilities



Outreach

Training



Webinars

Support Resources

FEMP-Designated Products



Federal Purchasers MUST Buy FEMP-Designated



Multiple laws, Executive Orders, and the Federal Acquisition Regulations have established a robust set of requirements that:

Federal purchasers MUST buy, specify, and contract for ENERGY STAR, FEMP-designated, and low standby products

Suppliers must provide only compliant products (look for FAR clause 52.223-15 in your contract)

References:

- Energy Independence and Security Act of 2007 (EISA)
- Energy Policy Act (EPAAct) of 1992 and 2005
- Executive Orders 13221, 13423 & 13514
- Federal Acquisition Regulation (FAR 23.2 and FAR 52.223-15)

FEMP-designated Efficiency Requirement for Exterior Luminaires

- FEMP-designated Efficiency Requirements (ER) established for 6 exterior lighting categories:

Category	Luminaire Efficacy Rating (LER)
Outdoor wall-mounted luminaires	60
Outdoor pole/arm-mounted area and roadway luminaires	65
Outdoor pole/arm-mounted decorative luminaires	65
Fuel pump canopy luminaires	70
Bollards	35
Parking garage luminaires	70

- These applications cover 97% of Federal exterior lighting*
- Does not overlap with ENERGY STAR® covered products
- Search “portal” being developed within DOE’s Lighting Facts® Program. Available later this Fall

*Based on data from PNNL’s Federal Market Assessment for Exterior lighting for FEMP

Light Output/Lumens
Measures light output. The higher the number, the more light is emitted.
Reported as "Total Integrated Flux (Lumens)" on LM-79 test report.

Watts
Measures energy required to light the product. The lower the wattage, the less energy used.
Reported as "Input Power (Watts)" on LM-79 report.

Lumens per Watt/Efficacy
Measures efficiency. The higher the number, the more efficient the product.
Reported as "Efficacy" on LM-79 test report.

IESNA LM-79-2008
Industry standardized test procedure that measures performance qualities of LED luminaires and integral lamps. It allows for a true comparison of luminaires regardless of the light source.

Registration Number
Model Number
Type

Brand X

lighting facts[®]

A Program of the U.S. DOE

Light Output (Lumens)	840
Watts	9
Lumens per Watt (Efficacy)	93
Color Accuracy	
Color Rendering Index (CRI)	87
Light Color	
2900 (Warm White)	
Correlated Color Temperature (CCT)	
	
2700K	3000K
4500K	
6500K	

All results are according to IESNA LM-79-2008: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the Label Reference Guide.

Registration Number: ABC4321HKT02023
Model Number: 18756CHT56428654RQHT1234HD
Type: 18756CHT56428654RQHT1234HD

Brand

Color Rendering Index (CRI)
Measures color accuracy.
Color rendition is the effect of the lamp's light spectrum on the color appearance of objects.

Correlated Color Temperature (CCT)
Measures light color.
"Cool" colors have higher Kelvin temperatures (3600-5500 K); "warm" colors have lower color temperatures (2700-3500 K). Color temperatures higher than 6500 are outside of the defined region for white light, but may be appropriate for outdoor applications.

www.lightingfacts.org

LED Lighting Facts® Products Search Tool

Show only fixture type:

(All Fixture Types)

Show only QA Verified products:

Only products which have been verified through Quality Assurance Testing to match the manufacturer's original performance claims will be displayed.

Light Output between



0 and 36000 lm

Watts between



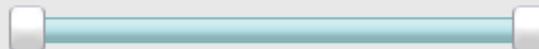
0 and 500 W

Lumens per Watt between



0 and 200 lm/W

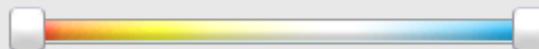
Color Accuracy (CRI)



0 and 100 (CRI)

between

Light Color (CCT) between



0 and 9900 K

5516

Products Match
Your Criteria

Search Within Your Criteria:

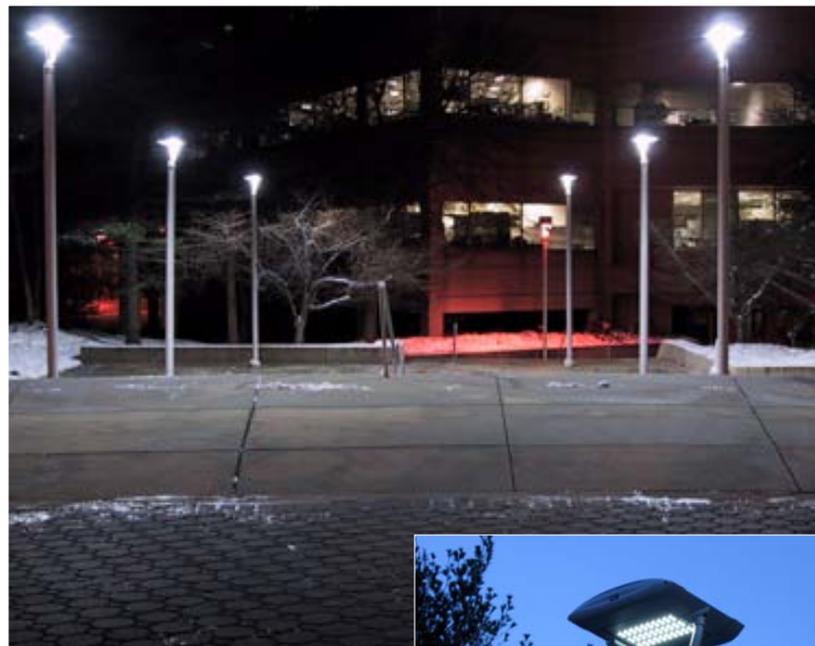
Search

Reset

www.lightingfacts.com

Federal Aviation Administration (FAA) William J. Hughes Technical Center in Atlantic City, NJ

- 6 LED luminaire replacements on 14-foot poles along exterior walkways
- Energy savings of up to 50%
- Lighting quality visibly improved
- Estimated 7-year payback for new construction (or replacing existing fixtures at their end of life)



Source: PNNL

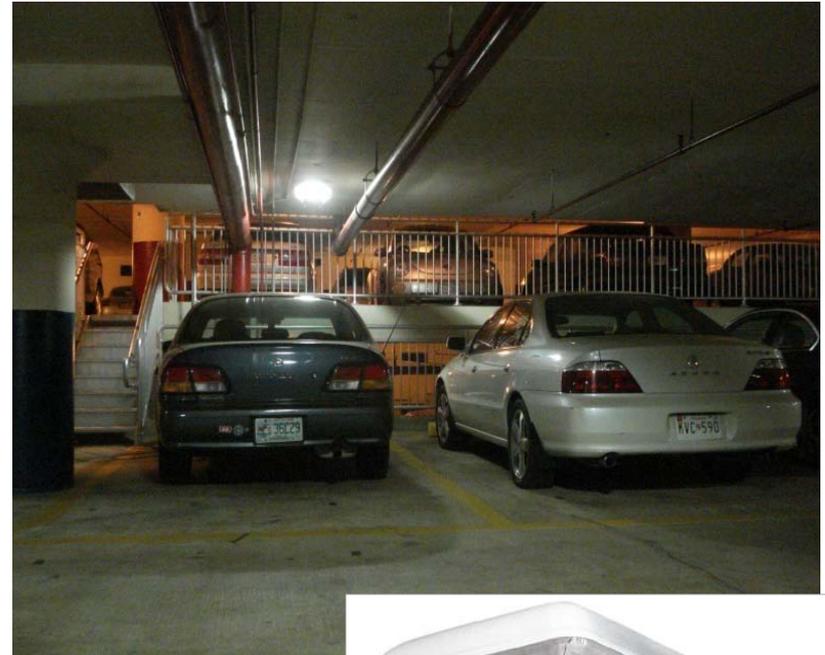
New LED Luminaires



Close-up of 3-Bar LED

US Department of Labor Building, Washington, DC

- Integral occupancy sensor dims fixture to 10% power
- Initial minimum horizontal illuminance increased 21%; average decreased 53%
- 55% installed wattage reduction in high state; 95% reduction in low
- ~80% kWh energy savings expected, includes dimming
- 1:1 replacement
- ~8 year simple payback (for retrofit), ~5 year for new



Source: PNNL

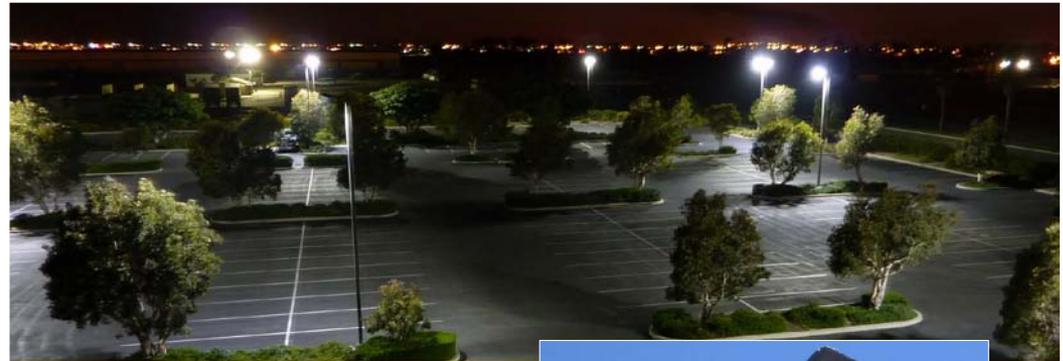
LED lighting installed in the parking garage of the Frances Perkins Building, U.S. Department of Labor headquarters, Washington, D.C.



Close-up of Philips Wide-Lite VizorLED

NAVFAC Engineering Service Center at Port Hueneme, CA

- Light levels increased by 18% in dimly lit areas
- Lighting power was reduced 74% to 2.81 kW from 10.88 kW
- Illumination distribution more uniform
- Higher CCT; 6500K for LED compared to 2000K for HPS
- Instant on – no strike or re-strike delay
- Longer lamp life; an expected 50,000 hours for the LEDs and driver versus 24,000 hours average for HPS



New LED parking area lights at the NAVFAC Engineering Service Center at Port Hueneme provide high quality, evenly distributed light.

Source: PNNL



Close up view of new LED luminaires atop an existing light pole.

“FEMP-designated” Covered Products

- www1.eere.energy.gov/femp/technologies

LED Lighting Facts[®]

- www.lightingfacts.com

DesignLights[™] Consortium

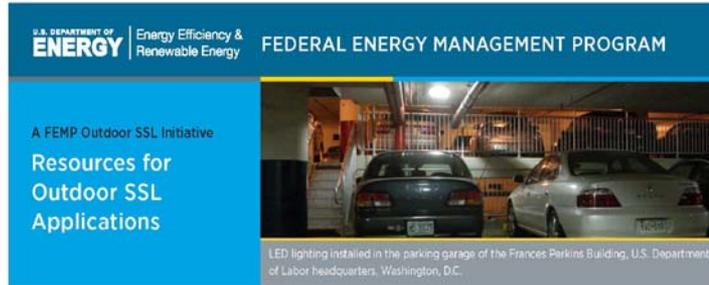
- www.designlights.org

DOE SSL Program

- www.ssl.energy.gov

Commercial Building Energy Alliance (CBEA)

- www1.eere.energy.gov/buildings/alliances/



Outdoor Solid-State Lighting in the Federal Sector

The Federal Energy Management Program (FEMP) is encouraging Federal agencies to accelerate the thoughtful application of outdoor solid state lighting luminaires. The FEMP Outdoor SSL Initiative offers a unique opportunity for the Federal sector to lead a large-scale implementation effort focused on an SSL application that is ripe for near term implementation through a process that recognizes the technology's potential, as well as its challenges. This initiative is intended to help Federal energy managers overcome the widespread misinformation they are encountering, learn about this technology and its unique attributes, and provide the tools needed to make good decisions that result in cost effective energy savings, and good quality lighting.

As part of this initiative, FEMP will leverage existing SSL outdoor tools and materials, and will develop new ones as needed to meet the unique needs of Federal agencies. This paper provides an overview of existing outdoor SSL resources developed by the US Department of Energy's SSL Program and other Federal initiatives including:

- SSL Street/Roadway Lighting
- SSL Site (Parking Lot/Garage) Lighting
- General SSL Resources

Street/Roadway Lighting

A variety of resources are available for facility managers interested in pursuing SSL street and roadway lighting, including DOE SSL GATEWAY demonstration project results, a Fitted Target Efficacy Calculator, and DOE CALIPER test results.

Municipal Solid-State Street Lighting Consortium Fact Sheet – The Consortium shares technical information and experiences related to LED street and area lighting demonstrations. The Consortium also serves as an objective resource for evaluating new products on the market intended for street and area lighting applications. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/consortium_fs.pdf

DOE SSL GATEWAY Demonstration Project Results – DOE GATEWAY demonstrations showcase high-performance LED products for general illumination in a variety of commercial and residential applications. Demonstration results provide real-world experience and data on state-of-the-art solid-state lighting (SSL) product performance and cost effectiveness. The following studies have been completed on Street/Roadway lighting:

• LED Roadway Lighting: Palo Alto, California

Assessment of energy, economic, and performance impacts of replacing high-pressure sodium street lights with LED and induction street lights.

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_palo_alto.pdf

According to the U.S. Department of energy, no other lighting technology offers as much potential to save energy and enhance the quality of our building environments, contributing to our nation's energy and climate change solutions.

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/dec2010_guiding-market_factsheet.pdf

• LED Street Lighting: Lija Loop, Portland, OR

Analysis of the energy and performance impacts of replacing eight high-pressure sodium street lights on one residential street with LED luminaires.

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_lija_loop.pdf

• LED Roadway Lighting: I-35W Bridge

Analysis of Phase 1 results, completed in September 2008, Phase 2 involves long-term monitoring to evaluate lumen depreciation, physical effects, and performance impacts over time.

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_i-35w-bridge.pdf

continued >

What are CEBAs?



The Commercial Building Energy Alliances (CBEAs) work with the U.S. Department of Energy (DOE) and its national laboratories to help guide research and encourage industry to move toward energy-efficient design and strategies.





- Requested by CBEA members
 - Retail/Commercial Real Estate and Hospital Alliances
 - Cross-cutting project
- Timeline
 - November 2010 a High Performance 2'x2' Troffer Committee was created
 - Specification completed May 2011
 - August 2011 DOE/CBEA decide to expand the 2'x2' spec. to add 1'x4' and 2'x4' troffers
 - Final specification issued Feb. 15, 2012
 - Initiate revision in November 2012

CBEA Specification

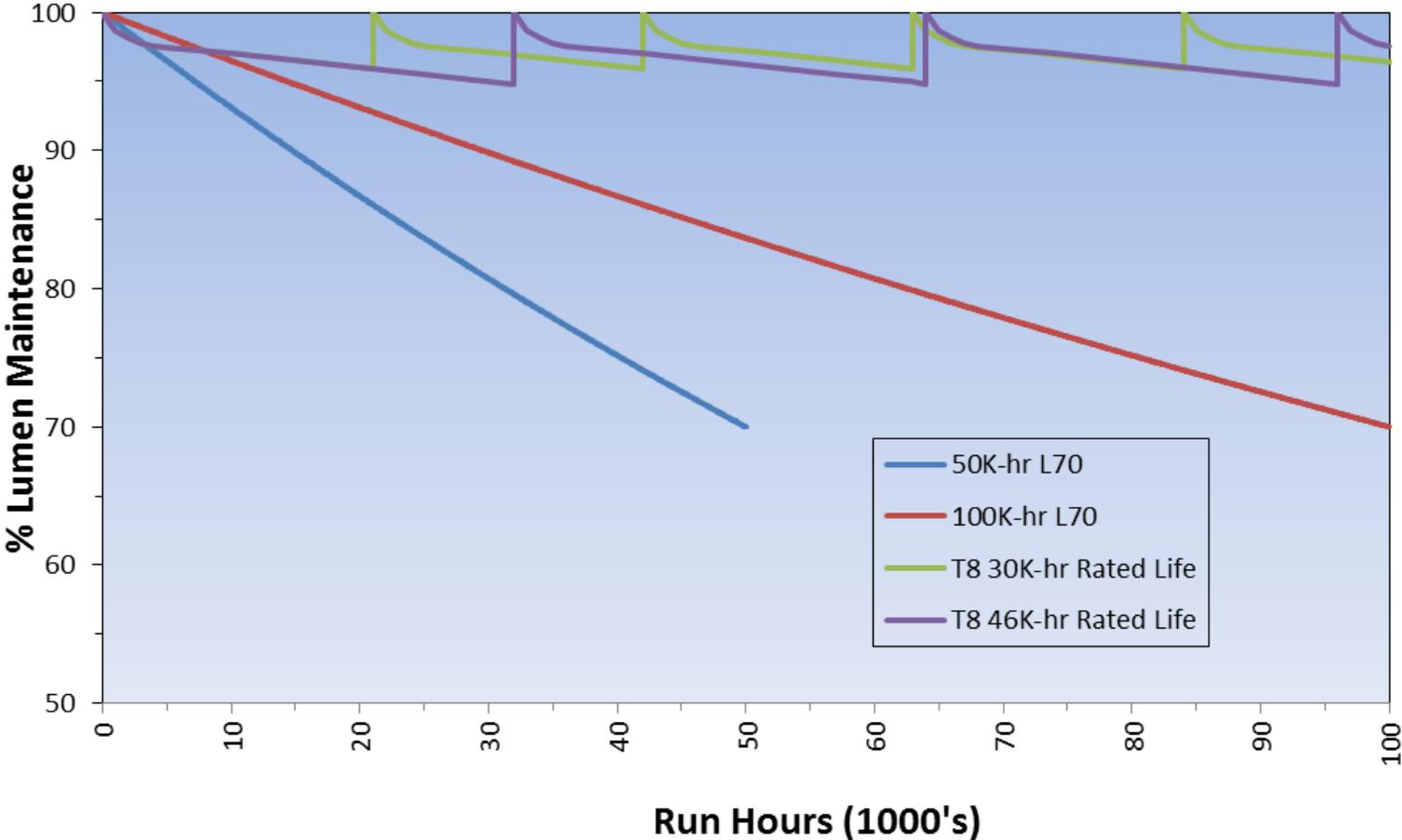
Light Output Characteristics

Configuration	Minimum Light Output		Luminaire Efficacy (lumens/W)	Spacing Criteria (SC)	
	LED	Fluorescent		0°-180°	90°-270°
2'x4'	4,000	3,600	74	1.05-1.40	1.15-1.80
2'x2'	3,000	2,700	69	1.05-1.40	1.10-1.70
1'x4'	2,000	1,800	74	1.05-1.40	1.15-1.80

- Chromaticity
 - CCTs: 2700, 3000, 3500, 4000/4100, 4500 (LED only) and 5000K
 - CRI: $R_a \geq 80$, $R_g > 0$
 - Must use LM-79 for LED

Lumen Maintenance Comparisons

Lamp Replacement at 70% of Rated Life



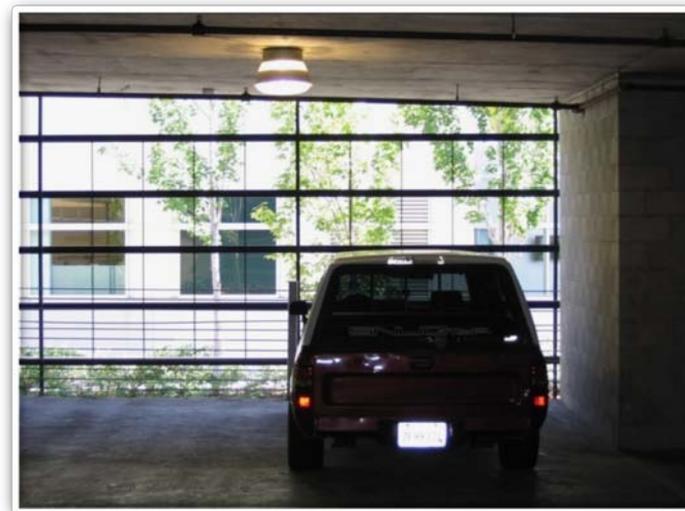
Parking Structure Lighting Requirements

Area of Structure	Horizontal ¹ Illuminance Requirement	Vertical ² Illuminance Requirement	Uniformity Max:Min	Uniformity CV
Covered Parking Areas	1.25 (Min)	0.5	7:1	0.38
Ramps (Day)	2.00 (Min)	1.0	10:1	0.41
Ramps (Night)	1.00 (Min)	0.5	10:1	0.41
Vehicle Entry (Day) ³	50.00 (Min)	25.0	10:1	0.41
Vehicle Entry (Night)	1.25 (Min)	0.5	10:1	0.41
Uncovered (Top Deck)	0.75 (Min)	0.4	10:1	0.41

1. Measured on parking surface
2. Vertical measurements at 5' AFG
3. Contributions from the sun should be factored in

A. Daylighting Controls

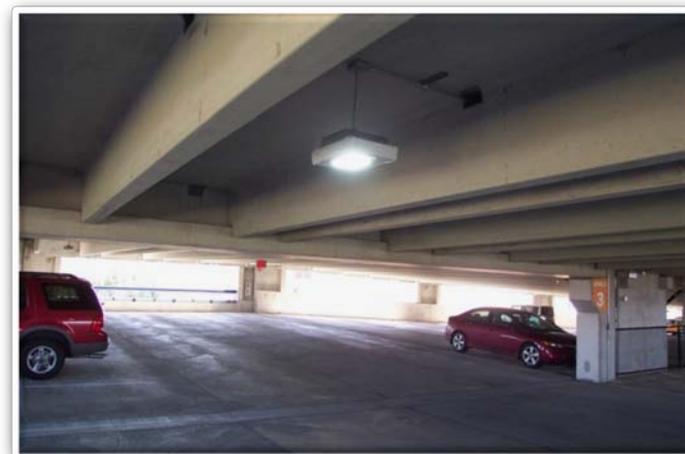
1. Luminaires within 20' of perimeter and if wall is 40% open must be controlled with daylight harvesting
2. Luminaires in vehicle exit/entry area turn off additional lighting at night
3. Photocell requirements
 - a. 15 – 30 second time delay
 - b. 10 fc set point for sensor
 - c. Mounted in an unobscured location
 - d. Use relays that are UL 773 or UL 773 A



Electric lighting & daylight
Hotel, Cupertino, CA
Source: PNNL

B. Occupancy Sensor Controls

1. 1 occ sensor per luminaire, maximum coverage
2. Sensors comply with WD 7-2000
3. Sensor Type: Infrared or microwave
4. Sensors not affected by ambient temperature
5. Failsafe feature to fail “on” in event of sensor failure
6. Site owner to specify if sensors are on/off or high/low



Universities at Shady Grove, Rockville, MD
Source: PNNL

Illuminance Requirements

Main (General) Parking Area

Ambient Condition	Horizontal Illuminance	Vertical Illuminance
Lighting Zone 0	N/A	N/A
Lighting Zone 1	N/A	N/A
Lighting Zone 2	0.50 fc	0.25 fc
Lighting Zone 3	0.75 fc	0.40 fc
Lighting Zone 4	1.00 fc	0.50 fc

Notes:

1. Values in table are minimum values
2. Horizontal illuminance is on the parking surface
3. Vertical illuminance is taken 5' above finished grade (AFG)

- Engage additional Federal Departments/Agencies
 - Provide policy development/implementation support
 - Limited technical assistance/case studies
- Modify cost effectiveness tool developed by DOE's Municipal Solid-State Street Lighting Consortium:
<http://www1.eere.energy.gov/buildings/ssl/consortium.html>
- Expand the program in include interior applications
 - Set new FEMP-designated performance levels
 - Conduct Federal interior lighting market assessment

FEMP Exterior SSL Initiative

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